

## CLAIMS

The embodiments of an invention in which an exclusive property or right is claimed are defined as follows:

1. A vertical cavity surface emitting laser for emitting light having a wavelength, comprising:
  - a substrate;
  - an active region adjacent said substrate;
  - a first mirror between said active region and said substrate; and
  - a second mirror adjacent said active region, said active region being between said second mirror and said first mirror; and
  - an ion implanted spatial region that extends into said active region;
  - wherein said second mirror includes an oxide insulating region; and
  - wherein said first mirror and said second mirror are separated by an optical path length of least one wavelength.
2. The vertical cavity surface emitting laser of claim 1, wherein said active region has at least one quantum well.
3. The vertical cavity surface emitting laser of claim 1, wherein said oxide insulating region and said ion implanted spatial region confine current flow through a center of said ion implanted spatial region.
4. The vertical cavity surface emitting laser of claim 1, wherein said ion implanted spatial region is concentrically aligned with said oxide insulating region.
5. The vertical cavity surface emitting laser of claim 1, wherein said oxide insulating region has an optical path length of less than  $\frac{1}{4}$  wavelength.

6. A vertical cavity surface emitting laser for emitting light having a wavelength, comprising:

a substrate;

an active region adjacent said substrate;

a first mirror between said active region and said substrate; and

a second mirror adjacent said active region, said active region being between said second mirror and said first mirror, said second mirror including a high aluminum content layer having an aluminum concentration sufficient for oxidizing the second mirror; and

an ion implanted spatial region that extends into said active region;

wherein said aluminum content layer is oxidized into an oxide insulating region; and

wherein said first mirror and said second mirror are separated by an optical path of at least one wavelength.

7. The vertical cavity surface emitting laser of claim 6, further including a first spacer between said first mirror and said active region, and a second spacer between said active region and said second mirror.

8. The vertical cavity surface emitting laser of claim 7, wherein said oxide insulating region extends into said second spacer.

9. The vertical cavity surface emitting laser of claim 6, wherein said substrate is doped with an n-type dopant.

10. The vertical cavity surface emitting laser of claim 6, wherein said active region has at least one quantum well.

11. The vertical cavity surface emitting laser of claim 6, wherein said oxide insulating region and said ion implanted spatial region confine current flow through a center of said ion implanted spatial region.

12. The vertical cavity surface emitting laser of claim 6, wherein said ion implanted spatial region is concentrically aligned with said oxide insulating region.

13. The vertical cavity surface emitting laser of claim 6, wherein said oxide insulating region has an optical path length of less than  $\frac{1}{4}$  wavelength.

14. A method of forming a vertical cavity surface emitting laser, comprising:

- forming a first electrical contact on a substrate;
- forming a first mirror structure on the substrate;
- forming a first spacer on the first mirror structure;
- forming an active region on the first mirror structure;
- forming a second spacer on the active region;
- forming a second mirror on the second spacer, wherein the second mirror includes an aluminum content layer having an aluminum concentration sufficient for oxidizing the second mirror;
- forming a conduction layer over the second mirror;
- forming a cap layer over the conduction layer;
- forming a second electrical contact on the cap layer;
- oxidizing the high aluminum content layer to form an oxide layer; and
- ion implanting at least part of the active region under the oxide layer;

wherein the first mirror and the second mirror are at least one wavelength apart along an optical path.

15. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the active region produces a quantum well.

16. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein oxidizing the aluminum content layer produces an annular shaped oxide layer.

17. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein ion implanting produces non-radiative centers in the active region.

18. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the second electrical contact includes forming an opening for light emission.

19. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the oxide layer is formed less than  $\frac{1}{4}$  wavelength thick.

20. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the oxide layer is formed in concentric alignment with implanted ions.

21. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the aluminum concentration is above 97%.

22. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the first spacer is a lower spacer.

23. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the second spacer is a top spacer.

24. The vertical cavity surface emitting laser of claim 6, wherein the aluminum concentration is above 97%.

Patent 4,648,300